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Antypenko Lyudmyla
Ph.D., Independent Researcher
Zaporizhzhia, Ukraine

Antypenko Oleksii
Ph.D., Associate Professor
Zaporizhzhia State Medical and Pharmaceutical University, Zaporizhzhia, Ukraine

Brytanova Tetiana
Ph.D., Assistant Professor
Zaporizhzhia State Medical and Pharmaceutical University, Zaporizhzhia, Ukraine

CROSS-INSTITUTIONAL SYNERGY IN BIOACTIVE COMPOUND RESEARCH: A SAME-CITY MULTI-UNIVERSITY COLLABORATIVE FRAMEWORK IN ZAPORIZHZHIA, UKRAINE

Annotation: *The paper proposes the framework for inter-university collaboration, focusing on the potential integration of three major universities of Zaporizhzhia, Ukraine. The study observes the impact of academic partnerships through a comprehensive assessment of resource optimization, educational enhancement, and innovation capabilities. The five-phase integration model, designed for investigation of novel biologically active substances, demonstrates how coordinated academic efforts can maintain educational excellence and research productivity even under challenging circumstances, while creating a foundation for sustained scientific development.*

The maintenance of academic continuity through inter-university collaboration has become crucial during military conflicts, particularly in the context of Ukrainian higher education institutions, where researchers face multiple challenges in wartime conditions [1]. In this context, learning environments require adaptability and flexibility to support student wellbeing and effective teaching practices [2]. Furthermore, the preservation of research infrastructure presents another critical aspect of wartime collaboration, as highlighted in discussions about Ukraine's human capital preservation in research and education [3].

International integration in higher education continues to evolve globally, with institutions developing new partnerships and collaborative approaches. As de Wit & Altbach [4] discuss, internationalization has become a significant trend in higher education, shaping how institutions approach global academic engagement and cooperation. While Ukrainian institutions face the ongoing wartime challenges, they operate within a broader context of evolving international academic integration.

These developments in international academic relationship contribute to the broader evolution of higher education systems.

To understand the multifaceted nature of inter-university collaboration, we can examine its key aspects across several categories (Table 1).

To understand the practical implications, the collaborative framework among universities offers several significant *advantages*. In terms of resource optimization, institutions can share specialized equipment and facilities, leading to more efficient use of research infrastructure. This sharing extends to funding opportunities, where combined grant applications strengthen the potential for financial support. Consequently, the collaborative approach also enables cost reduction through joint resources, making advanced research more feasible for all participating institutions.

Beyond resource considerations, academic and research enhancement represents another crucial benefit of inter-university collaboration. Within this framework, the cross-pollination of ideas between different scientific fields creates a rich environment for innovation, while the integration of theoretical and practical approaches leads to more comprehensive research outcomes. As a result, the diversity of expertise enhances research quality and creates stronger publication potential through multi-disciplinary insights.

Table 1

The key aspects of inter-university collaboration

Category	Advantages	Challenges
Resources & Infrastructure	• Shared specialized equipment and facilities • Enhanced funding opportunities through combined grant applications • Cost optimization through joint operations	• Complex resource allocation due to different institutional policies • Varying budget constraints and funding cycles affecting project continuity • Difficulties in coordinating shared resource usage
Academic & Research	• Cross-pollination of ideas between scientific fields • Integration of theoretical and practical approaches • Enhanced research quality through diverse expertise • Stronger publication potential *via* multi-disciplinary insights	• Different methodological approaches between disciplines • Varying research standards and protocols across institutions • Communication barriers between specialists • Time delays from multi-institutional approval processes
Innovation & Implementation	• Faster pathway from basic research to practical applications • Comprehensive problem-solving approaches • Higher potential for breakthrough discoveries	• Intellectual property rights complications • Data sharing and security concerns • Conflicts in publication authorship

Continuation of the table 1

Category	Advantages	Challenges
	• Better commercialization opportunities • Increased potential for patents and an intellectual property development	
Administrative & Practical	• Combined institutional strengths for larger projects • Shared administrative resources	• Complex coordination between different institutional bureaucracies • Conflicts in research priorities and timelines • Physical distance barriers between institutions

Authors' contribution

Significantly, innovation and implementation capabilities are boosted through collaborative efforts. In particular, the partnership enables a faster pathway from basic research to practical applications, supported by a more comprehensive problem-solving approach. This environment, in turn, cultivates a higher potential for breakthrough discoveries, better commercialization opportunities, and increased potential for patents and intellectual property development.

Despite these advantages, several *challenges* must be addressed in such collaborations (Table 1). Specifically, administrative challenges include complex coordination between different institutional bureaucracies and potential conflicts in research priorities and timelines. Resource allocation and sharing face complications due to different institutional policies and procedures, while coordinating schedules and meetings across multiple institutions presents ongoing challenges.

Research process complications also pose another set of challenges. Different methodological approaches between disciplines and potential communication barriers between specialists can impede progress. Varying research standards and protocols across institutions, combined with time delays due to multi-institutional approval processes, create additional complexity in maintaining consistent research quality across teams.

Practical constraints further complicate collaborative efforts. The physical distance between institutions can hamper direct interaction, while different funding cycles and budget constraints affect project continuity. Intellectual property rights complications, data sharing and security concerns, and potential conflicts in publication authorship require careful management and clear agreements between participating institutions.

The administrative and practical challenges in inter-university collaboration present a complex web of interconnected issues that demand careful attention and

strategic management. Primarily, the challenge lies in the complex coordination between institutional bureaucracies, where each university operates within its distinct organizational system. This multiplicity creates operational challenges, when attempting to align procedures, often requiring parallel approval processes and involving multiple stakeholders in decision-making. The resulting administrative landscape becomes increasingly intricate as more institutions join the collaboration.

Furthermore, research priorities and timeline conflicts present another significant hurdle in the collaborative process. Universities often pursue distinct strategic research directions, while their academic calendars and semester timings may not perfectly align. This misalignment affects project milestone scheduling and resource allocation timing, requiring careful negotiation and planning among partner institutions to maintain project momentum and achieve shared objectives.

Moreover, physical distance between institutions introduces practical complications that limit opportunities for spontaneous collaboration and increases both travel costs and time investments. When institutions span different regions or time zones, the complexity of organizing face-to-face meetings increases, and real-time communication becomes more challenging to coordinate effectively.

Consequently, the interconnected nature of these challenges means that they often compound each other, creating situations where addressing one issue may inadvertently affect another. Success in inter-university collaboration therefore requires developing comprehensive solutions that take into account the full spectrum of administrative and practical challenges, rather than attempting to address each in isolation.

While the theoretical framework provides comprehensive understanding, examining real-world cases of university collaborations provides valuable insights into successful partnership strategies. In particular, several documented cases of university partnerships demonstrate how institutions have successfully implemented collaborative frameworks across different geographical contexts and academic domains. Table 2 presents examples of such collaborations, highlighting the diversity of approaches and outcomes in inter-university partnerships

These collaborations demonstrate diverse approaches to inter-university partnerships. The Nottingham-Kampala collaboration exemplifies international knowledge exchange in healthcare systems, while the Seattle-based partnership focuses on curriculum development in specialized medical education. The St. Louis case shows how multiple institutions within one metropolitan area can collaborate effectively on professional education programs.

Table 2

Intercity university collaborations

City, Country	Universities	Project Focus	Citation
Nottingham, UK & Kampala, Uganda	Nottingham Trent University & Makerere University	Healthcare system support & Public health	Musoke *et al.* (2016) [5]
Seattle, USA	University of Washington & Partner universities	Global health integration in dental education	Seminario *et al.* (2020) [6]
St. Louis, USA	Multiple universities in St. Louis Area	Interprofessional geriatric care education	Talley *et al.* (2024) [7]

Based on [5-7].

Notably, while cross-city and international collaborations are well-documented in academic literature, same-city university partnerships often remain underreported despite their significant potential for immediate impact and resource optimization. The proximity of institutions within the same city creates unique opportunities for deeper integration and more efficient resource sharing, while potentially minimizing many of the practical challenges outlined in Table 1, particularly those related to physical distance and coordination.

In light of these examples, the situation in Zaporizhzhia, Ukraine presents a unique opportunity to examine same-city collaboration under challenging circumstances between three major universities with complementary strengths and resources. Notably, the proximity of Zaporizhzhia State Medical and Pharmaceutical University [8], Zaporizhzhia National University [9], and National University 'Zaporizhzhia Polytechnic' [10] creates favorable conditions for establishing an integrated research and educational ecosystem, especially crucial in the current conditions of wartime.

The academic structure of Zaporizhzhia, Ukraine, outlines three major universities. The Zaporizhzhia State Medical and Pharmaceutical University (ZSMPhU), that focuses on medical and pharmaceutical education, featuring multiple Medical faculties, Pharmacy faculties, and an International faculty [8]. The Zaporizhzhia National University (ZNU), that offers a broad range of traditional academic disciplines across 12 faculties, including Biology, Economics, Mathematics, Journalism, Foreign Languages, History, Psychology, Management, Physical Education, Law, and more [9]. And the National University "Zaporizhzhia Polytechnic", that has a strong emphasis on technical and engineering education, with faculties dedicated to Engineering and Physics, Electrical Engineering, Computer Science, Information Security, Mechanical Engineering, and Construction, while maintaining a diverse offering of non-technical programs through its faculties of Business Technologies, Humanities, Physical Culture, Law, and Social Sciences [10].

The distinct specializations of these three universities create natural synergies, that can be strategically leveraged through a five-phase integration model (Table 3).

The proposed collaboration between Zaporizhzhia's universities for combined studies represents a comprehensive integration of academic strengths and resources. Building upon this foundation, the proposed model demonstrates a systematic approach to inter-university collaboration in bioactive substances research, leveraging each institution's unique strengths. The phased structure enables progressive development, while maintaining clear focus and accountability.

During the *Initial Integration Phase*, the combination of ZSMPhU's pharmaceutical expertise with Polytechnic's engineering capabilities creates a strong foundation for synthesis optimization. ZNU's contribution in mathematics and biology completes the interdisciplinary framework necessary for comprehensive compound development and testing.

Moving to the *Core Research Phase* builds upon this foundation by integrating multiple faculties across all three institutions. This phase is particularly significant as it combines theoretical design with practical implementation, supported by advanced computational modeling and activity screening. The involvement of Polytechnic's materials expertise ensures scalability of successful syntheses.

Table 3

Integration phases and institutional contributions in bioactive substances research

Phase	Key activities	Contributing university / faculty	Expected outcomes
Initial Integration	• Synthesis optimization methods • Computational modeling • Biological testing setup	• ZSMPhU / Pharmacy • Polytechnic / Construction, Architecture and Design • ZNU / Mathematics, Biology	Establishment of foundational research protocols and team structures
Core Research	• Bioactive compound design • Activity screening • Scale-up engineering • Drug-target modeling	• ZSMPhU / Pharmacy, Medicine • ZNU / Biology, Mathematics • Polytechnic / Construction, Materials	Development of novel compounds and testing methodologies
Advanced Development	• Laboratory equipment design • Data security protocols • Process automation • Economic assessment	• Polytechnic / Engineering, Security • ZSMPhU / Pharmacy • ZNU / Economics	Technical infrastructure and viability analysis

Continuation of the table 3

Phase	Key activities	Contributing university / faculty	Expected outcomes
Implementation & Management	• Project management • Legal framework • Business strategy	• All institutions / Management • ZNU & Polytechnic / Law • Polytechnic / Business	Operational framework and commercialization strategy
Documentation & Communication	• International protocols • Technical documentation • Research communication	• ZSMPhU / International • Polytechnic / Computer Science • ZNU / Journalism, Languages	Comprehensive documentation and dissemination system

Authors' contribution

As development progresses, the *Advanced Development Phase* marks a transition from pure research to practical implementation, with Polytechnic's various engineering departments playing a central role in infrastructure development. The inclusion of economic assessment at this stage ensures commercial viability is considered early in the development process.

Following this, the *Implementation and Management Phase* demonstrates the importance of cross-institutional coordination, particularly in legal and business aspects. This phase is crucial for translating research outcomes into practical applications, with each institution contributing to different aspects of project management and commercialization.

Finally, the *Documentation and Communication Phase* ensures proper dissemination of research outcomes and maintenance of international collaboration standards. This phase is essential for long-term sustainability and potential expansion of the research program.

Through this structured approach, each university's resources are maximized, while creating a replicable model for similar collaborative initiatives in other contexts. Importantly, the geographical proximity of institutions facilitates regular interaction, making it particularly effective for universities within the same city.

Conclusions. The five-phase integration model established between Zaporizhzhia's three major universities demonstrates, how structured academic collaboration can sustain research excellence under wartime conditions. This partnership exemplifies academic resilience by addressing immediate challenges of students and compromised facilities, while building a foundation for sustained scientific innovation.

The framework's success provides valuable insights for higher education institutions facing similar challenges, showing how coordinated efforts can preserve academic excellence even under extreme circumstances. Moving forward, the effectiveness of such initiatives relies on three key factors: sustained institutional commitment, strategic resource management, and organizational adaptability - all while upholding rigorous academic standards.

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